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LANDSAT Follow-on Investigation #22510
Type II Progress Report #7
Three Months Ending 1 December 1976

The Use of LANDSAT DCS and Imagery in Reservoir Management and Operation

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(E77-10130) THE USE OF LANDSAT DCS AND IMAGERY IN RESERVOIR MANAGEMENT AND OPERATION Progress Report, period ending 1 Dec. 1976 (Corps of Engineers, Waltham, Mass.) 8 p HC A02/MF A01 CSCL 08H G3/43 00130 N77-20538 Unclas

1. ACCOMPLISHMENTS

a. DCS - The LANDSAT DCS and NED's Ground Receive Station have continued to perform up to expectations. The NED computerized automatic tracking operation has operated faultlessly for over two months, but data collection was interrupted for three days due to an RF cable working loose inside the tracking pedestal (service charges to find the malfunction amounted to $484.55).

A site list showing the latest placement of DCP's is attached (Figure 1). Several new features have been introduced to our DCS investigation. The Cold Regions Research and Engineering Laboratory (CRREL) developed new snow pillow interfaces for our use in northern Maine and their use in North Dakota. These devices were installed in September and October, and began transmitting with ID numbers 7147, 7325 and 7103-7105.

In a cooperative venture involving NED, CRREL, and the University of Maine, a complex temperature sensing DCP has been installed on Sugarloaf Mountain, Kingfield, Maine. The platform (designed by Blanchard Pratt of CRREL) consists of a chain of 27 thermocouples arranged in four banks, a multiplexing interface, an electrical temperature compensating circuit to obviate an absolute reference temperature, a LaBarge convertible DCP (ID 7125), and a Ball antenna. Power is supplied by batteries and a charger to

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convert 120 volt AC. A program for decoding the thermocouple data was written at NED, and a copy of the program (TCDECODE) and a sample of its output are attached (Figures 2 and 3).

A second revision of the manual entitled: "Operation of LANDSAT Automatic Tracking System", written by Timothy D. Buckelew has been prepared. Although originally intended for inhouse use, the manual has been requested by several outside agencies as well. The manual provides complete instructions for tracking LANDSAT, managing computer data files, routine operation and trouble-shooting associated with NED's ground receive station.

A DCP (ID 7101) that serves a dual purpose has been installed in NED's communications computer room. It is used as a demonstration set for the many visitors who view the system, and serves as a working spare for field placement. The set consists of a LaBarge convertible DCP, a tipping-bucket rain gage, a Leupold-Stevens ADR, a Solarex solar panel with associated charging regulator, and Gel-cel batteries.

b. Imagery - Work continues on schedule on the imagery aspect of this investigation as outlined in past progress reports. Selected CCT scenes for test sites in the Saint John watershed in Maine are being analyzed on the GISS computer to define snow radiance values, with the final aim of estimating snow water equivalence. Results will be presented in the Type III final report, scheduled for April 1977.

2. MAJOR PROBLEMS

a. DCS - Twice during this quarter ATT service failed, and communication on the NASCOM to NED teletype was interrupted for several days both times, as circuits had been left open by local service personnel.

The two snow pillows deployed by NED have not been transmitting valid data. The one in Maine is beyond repair for the winter due to remoteness of the site.

b. Imagery - No major problems.

3. SIGNIFICANT RESULTS

a. DCS - Recently we reviewed the performance history of all DCP's placed in the field, and the summary shows that DCP's are very reliable.

Figure 4 depicts the life history of data collection platforms that have been placed at remote locations in New England from 1972 to the present. This data has been compiled from field technician's records to assess the reliability of DCP's. Available records include the duty cycle (sometimes intermittent) of 23 DCP's over a span of approximately four years for a total service history of 70.1 DCP-years. During this time several events could force a visit to the DCP site: initial installation, repair, preventive maintenance, battery change, or vandalism. For this analysis, final removal was not defined as a forced visit since removal was not urgent in most cases. Over the 70.1 DCP-years there were about 95 forced visits for an average of approximately 1.4 forced visits per DCP-year. In other words, on an average slightly under nine months elapsed between two forced visits to the same DCP.

Note that our early experience (or inexperience) with DCP's is included in this analysis, so it may be assumed that for us or another experienced group to start now with the knowledge gained would involve far fewer DCP failures and on the average assure nine months or more between forced visits.

4. MEETINGS AND VISITORS

On 15 October 1976, Alan Flanders of the National Weather Service in Silver Spring, Maryland, visited NED to view our ground receive station and promote data exchange between NED and the River Forecast Center in Bloomfield, Connecticut.

On 19-20 October 1976, Mr. Timothy Buckelew of NED and Dr. Harlan McKim and Ms. Carolyn Merry of CRREL attended a command briefing before a panel of discipline specialists at NASA-GSFC.

5. RECOMMENDATIONS

None stemming from this quarter's activities.

6. FUTURE PLANS

All personnel at NED or CRREL engaged in this Follow-on Investigation are now preparing the Type III final report due in April 1977. The present document will be the last Type II progress report to be issued as the final report is so close at hand.

Plans are underway for a new DCP application to transmit important water quality data from the Saint John and Allagash Rivers in northern Maine to NED by LANDSAT DCS. The water quality in that region is now being monitored in connection with the proposed Dickey-Lincoln School power dams to be constructed in Maine. Most of the equipment needed to accomplish the data transmission is on hand, and an attempt will be made to interface DCP's to existing USGS equipment prior to spring runoff. Present plans call for the monitoring of this data in real time for two years.

Saul Cooper

SAUL COOPER
Principal Investigator

LANDSAT-2 - DCP INFORMATION SHEET
U.S. ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION 4 JANUARY 1976

DCP NO.	STATION NAME	PARAMETER(S)(4)	LAT	LONG
7171	ST. JOHN RIVER AT NINEMILE BRIDGE, ME.	PS WES	46 42 00	69 42 59
7273	ST. JOHN RIVER AT FORT KENT, ME.	PS	47 15 27	68 35 35
7147	MICHAUD FARM AT ALLAGASH FALLS, ME.	WES	46 57 05	69 11 43
7071	PENOBSCOT RIVER AT WEST ENFIELD, ME.	PS	45 14 12	68 38 56
7272	CARABASSETT RIVER NEAR NORTH ANSON, ME.	PS	44 52 09	69 57 20
7356	SACO RIVER AT CORNISH, ME.	PS	43 48 35	70 46 53
7127	SOUTH MOUNTAIN, N.H.	P	42 58 59	71 35 21
7201	PEMIGEWASSET RIVER AT PLYMOUTH, N.H.	PS	43 45 33	71 41 10
7207	MERRIMACK RIVER NEAR GOFFS FALLS, N.H.	PS	42 56 54	71 27 52
7246	WACHUSETT MOUNTAIN, MA.	P	42 29 24	71 53 15
6063	IPSWICH RIVER NEAR IPSWICH, MA. (1)	PS	42 39 35	70 52 39
7271	NORTH NASHUA RIVER AT FITCHBURG, MA.	PS	42 34 34	71 47 19
7142	CHICOPEE RIVER AT CHICOPEE FALLS, MA.	WQ	42 09 27	72 34 52
7021	WESTFIELD RIVER AT WEST SPRINGFIELD, MA.	WQ	42 05 59	72 33 28
7107	NED, WALTHAM, MA. (LABARGE)	P	42 23 46	71 12 56
7325	NED, WALTHAM, MA.	WES	42 23 46	71 12 56
7220	BRANCH RIVER AT FORESTDALE, R.I.	PS	41 59 47	71 33 47
7345	PAWTUXET RIVER AT CRANSTON, R.I.	PS	41 45 03	71 26 44
7254	CONNECTICUT RIVER AT HARTFORD, CT.	PS	41 46 10	72 40 04
7242	CONNECTICUT RIVER NEAR MIDDLETOWN, CT.	PS	41 33 40	72 36 45
7206	PORTER BROOK NEAR MANCHESTER, CT. (2)	PS	41 45 55	72 30 12

7214,6216,7042 (3) PL,AT,GST,GT,WP
7103-7105,7110-7120 ASSIGNED TO CRREL'S C/DCP'S
7304,7012,7233,7355,7106,7335,7010 SPARES

\# P - PRECIPITATION
WES - WATER EQUIVALENT OF SNOWPACK
PS - RIVER STAGE
PL - RESERVOIR LEVEL
WQ - WATER QUALITY (TEMPERATURE, CONDUCTIVITY, PH AND DISSOLVED OXYGEN)
AT - AIR TEMPERATURE(S)
GST - GROUND SURFACE TEMPERATURE
GT - GROUND TEMPERATURE(S)
WP - WIND PASSAGE
PV - PARAMETERS VARIABLE
T - TEST SET

(1) DCP OPERATED BY U.S. GEOLOGICAL SURVEY, BOSTON, MA.
(2) DCP ON LOAN TO U.S. GEOLOGICAL SURVEY, HARTFORD, CT.--ON DEMONSTRATION AT THE MANCHESTER NATURE CENTER
(3) DCP ON LOAN TO U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LAB, HANOVER, N.H.
(4) NOT YET INSTALLED

FIGURE 1. DATA COLLECTION PLATFORM SITELIST

```
      INTEGER EFLAG,OCT(8)
      DIMENSION NUM(24),SUM(8),T(8)
      COMMON/CONV/EMF(23)
      DATA EMF/-1818.7,-1648.01,-1474.73,-1298.94,
     $-1120.67,-939.91,-756.7,-571.04,-382.38,-192.61,
     $00.0,194.6,390.9,589.2,789.4,991.7,1196.2,1402.7,1611.4
     $,1822.2,2035.2,2250.3,2467.5/

      WRITE(10,300)
300   FORMAT(' PROGRAM TO DECODE THERMOCOUPLE READINGS'
     $' TRANSMITTED FROM SUGARLOAF MOUNTAIN, MAINE'
     $' VIA LANDSAT SATELLITE.'//' THE FOLLOWING LISTING HAS THE
     $FORMAT:'//' DCP#     DATE   TIME      BANK#:
     $FINAL,PAN      PAN DATA(OCTAL)'/
     $35X,' TEMPERATURES(C)'//)

      CALL OPEN(5,'CRELDAT',1,IER)
      IF(IER.EQ.1)GO TO 2
      TYPE 'OPEN ERROR',IER
      CALL EXIT
2     CONTINUE
1     READ(5,6,END=200)IY,IM,IDAY,IHR,IMIN,ISEC,IERR,IPID,NUM
6     FORMAT(I1,5I2,A1,I4,2I11)
      IF(IERR.EQ.42440)GO TO 1
      DO 10 I=1,8  ;CREATE 8 OCTAL NUMBERS
      OCT(I)=0
      DO 20 J=1,3
      JJ=(I-1)*3+J
20    OCT(I)=OCT(I)+NUM(JJ)*8**(3-J)
10    CONTINUE


      DO 40 I=1,8  ;SWAP 4-BIT BYTES IN EIGHT WORDS
      ITEMPR=IAND(OCT(I),17)*16
      ITEMPL=IAND(OCT(I),360)/16
      OCT(I)=IOR(ITEMPL,ITEMPR)
40    CONTINUE

      EFLAG=0

      NB=IAND(OCT(1),17)  ;BANK# IS IN RIGHT BYTE
      IF(NB.EQ.11)EFLAG=1  ;DECIDE WHETHER TO PRINT AMP VOLTAGE
      NNB=MOD(NB,4)+1  ;REDUCE BANK# TO 1,2,3, OR 4

      DO 50 I=2,8  ;SEVEN DATA WORDS
      T(I)=0.
      SUM(I)=0.
      N=OCT(I)


      DO 70 J=1,7  ;SEVEN BITS TO TEST
      KK=7-J  ;DATA GENERAL BIT POINTER
      SUM(I)=SUM(I)-(ITEST(N,KK))*2**FLOAT(J)
70    CONTINUE

C                       NOW TEST FOR + OR -
      IS=ITEST(N,7)  ;DG SAYS:0 FOR 0,-1 FOR 1
      IF(IS.EQ.0)SUM(I)=-SUM(I)  ;DCP SIGN IS - FOR 0
C                                          + FOR 1

      SUM(I)=(SUM(I)+35.)/10.  ;MICROVOLTS

      DO 80 IPOS=1,23  ;CHECK 23 EMF'S
      IF(SUM(I).GE.EMF(IPOS)
     $.AND.SUM(I).LT.EMF(IPOS+1))GO TO 81
80    CONTINUE
81    T(I)=(IPOS)*5.-85.) + 5.*(SUM(I)-EMF(IPOS))
     $(EMF(IPOS+1)-EMF(IPOS))
      IF(EFLAG.EQ.1.AND.I.EQ.8)T(I)=SUM(I)  ;AMPLIFIER PDG.


C     NEXT EIGHT STEPS ROUND EVEN TENTHS DOWN AND
C     ODD TENTHS UP WHEN HUNDREDTHS DIGIT IS 5.
      II=SUM(I)
      TSUM=SUM(I)-II
      I10THS=TSUM*10.  ;10THS DIGIT
      I100THS=(TSUM*10.)-I10THS)*10.  ;100THS DIGIT
      IF(I100THS.GE.5)GO TO 50
      IF(ITEST(I10THS,0).EQ.-1)GO TO 50  ;ODD TENTHS DIGIT
      II=SUM(I)*10.  ;ZERO THE HUNDREDTHS DIGIT
      SUM(I)=FLOAT(II)/10.  ;DITTO
50    CONTINUE

      IY=IY+70
      WRITE(10,100)IPID,IM,IDAY,IY,IHR,IMIN,ISEC,NNB,NUM
     $,(T(I),I=2,8)
100   FORMAT(1X,I5,1X,I2,2('-',I2),I3,2(':',I2),'GMT',
     $' BANK',I3,',',I3,1X,2I11,23(',F7.1))

      GO TO 1

200   CALL EXIT
      END
```

FIGURE 2. "TCDECODE", A PROGRAM TO DECODE THERMOCOUPLE DATA FROM SUGARLOAF MOUNTAIN, KINGFIELD, MAINE.

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TCDECODE
PROGRAM TO DECODE THERMOCOUPLE READINGS
TRANSMITTED FROM SUGARLOAF MOUNTAIN, MAINE
VIA LANDSAT SATELLITE.

THE FOLLOWING LISTING HAS THE FORMAT:

DCP#      DATE    TIME       BANK#:FINAL,RAW      RAW DATA(OCTAL)
                                    TEMPERATURES(C)


 7125 11/ 2/76 14:42:59GMT BANK  4, 15 375061141161021261041340
                            4.1    3.3    3.1    4.6    2.1    4.4    5.4

 7125 11/ 2/76 14:45:22GMT BANK  4, 15 375061141161021261041340
                            4.1    3.3    3.1    4.6    2.1    4.4    5.4

 7125 11/ 3/76 13: 6:15GMT BANK  2,  1 037264142102361222102002
                          -10.5   -0.8   -0.3    1.0   -1.6   -0.3    0.8

 7125 11/ 3/76 14:49:12GMT BANK  2,  1 037264142102361222102002
                          -10.5   -0.8   -0.3    1.0   -1.6   -0.3    0.8

 7125 11/ 3/76 14:51:34GMT BANK  2,  1 037264142102361222102002
                          -10.5   -0.8   -0.3    1.0   -1.6   -0.3    0.8

 7125 11/ 4/76  0:45:21GMT BANK  3,  2 057203162322122222142062
                           -5.5   -1.0   -2.6   -0.5   -1.6   -0.8    0.0

 7125 11/ 5/76 13:16:17GMT BANK  2,  5 137047027347167207000347
                          -20.9  -20.6  -24.2  -22.3  -22.5    9.0  -24.2

 7125 11/ 5/76 13:18:38GMT BANK  2,  5 137047027347167207000347
                          -20.9  -20.6  -24.2  -22.3  -22.5    9.0  -24.2

 7125 11/ 6/76  0:54:56GMT BANK  3,  6 157221161241121161141201
                            2.6    3.1    2.3    3.6    3.1    3.3    2.8
```

FIGURE 3. SAMPLE OF DATA OUTPUT OF 'TCDECODE'.

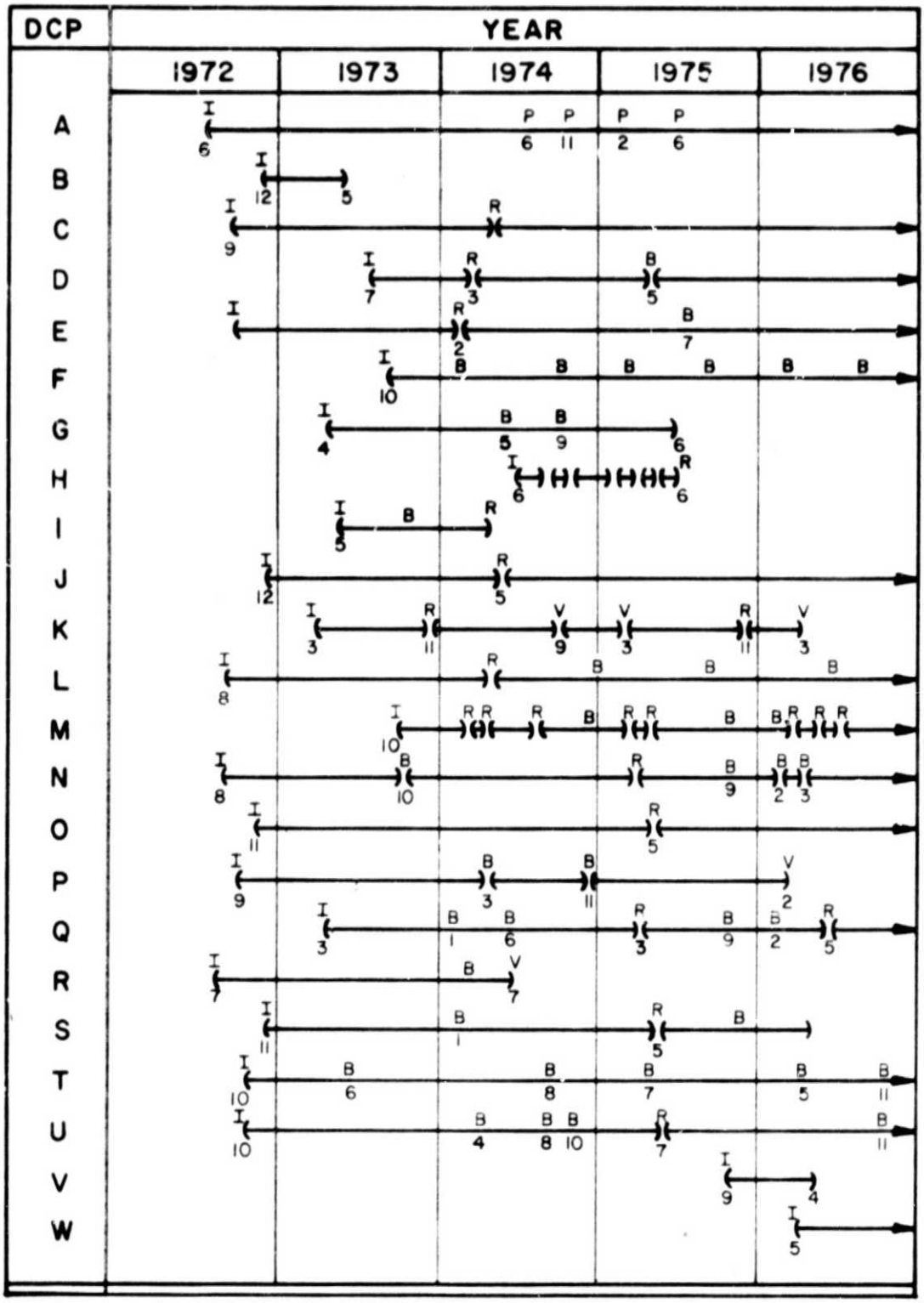

FIGURE 4. LIFE HISTORY OF NEDS DATA COLLECTION PLATFORMS

LEGEND:

)(	INTERRUPTION IN REPORTING	I	ORIGINAL INSTALLATION DATE
R	REPAIR	P	PREVENTIVE MAINTENANCE
B	BATTERY CHANGE	V	VANDALISM